January, 1995
NSRP 0439

SHIP PRODUCTION COMMITTEE
FACILITIES AND ENVIRONMENTAL EFFECTS
SURFACE PREPARATION AND COATINGS
DESIGN/PRODUCTION INTEGRATION
HUMAN RESOURCE INNOVATION
MARINE INDUSTRY STANDARDS
WELDING
INDUSTRIAL ENGINEERING
EDUCATION AND TRAINING

THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

1995 Ship Production Symposium

Paper No. 2: Technology Development: A European Experience

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JAN 1995**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE **The National Shipbuilding Research Program, 1995 Ship Production Symposium: Paper No. 2: Technology Development: A European Experience**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Naval Surface Warfare Center CD Code 2230 - Design Integration Tower Bldg 192 Room 128 9500 MacArthur Blvd Bethesda, MD 20817-5700**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**21**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

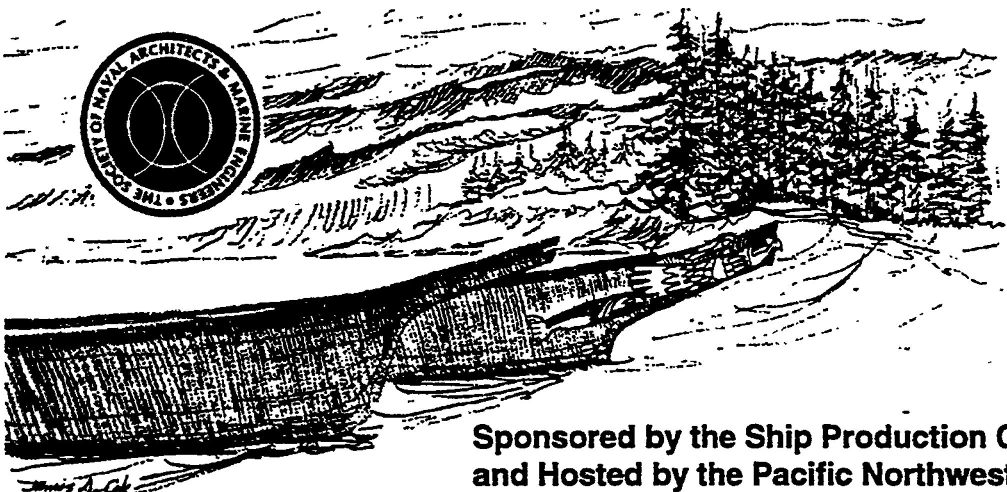
DISCLAIMER

0439

1995 SHIP PRODUCTION SYMPOSIUM

Commercial Competitiveness for Small and Large North American Shipyards

Seattle, Washington
The Westin Hotel
January 25-27,1995



Sponsored by the Ship Production Committee
and Hosted by the Pacific Northwest Section of
The Society of Naval Architects and Marine Engineers
601 Pavonia Avenue
Jersey City, New Jersey 07306
Phone (201) 798-4800
Fax (201) 798-4975

THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
601 PAVONIA AVENUE, JERSEY CITY, NJ 07306
Paper presented at the 1995 Ship Production Symposium
Westin Hotel, Seattle, Washington, January 25-27, 1995

Technology Development: A European Experience

John Craggs (M) and Malcolm Bell (V), First Marine international Limited, **U. K.; Simon Quarrell (V), KPMG** Peat Marwick, Europe; **and Francisco Laranjeira (V),** Estaleiros Navais de Viana do Castelo, Portugal

ABSTRACT

Since January 1993, the Estaleiros Navais de Viana do Castelo (ENVC) shipyard in Portugal has been engaged in a program of productivity improvement. In many other shipyards, the traditional approach has been to select wide ranging technology projects and to employ large teams of advisors and counterman managers. The approach here has been to involve key functional areas with wide involvement of yard personnel in driving the program forward. The consultancy team has been small and has acted as a catalyst and advisor on the management of change and the specification and implementation of new technology.

The central theme has been the establishment of workstation operations. The emphasis of the project has been in developing a structured approach to productivity improvement through the implementation of "best practice". The objective has not been to implement perceived latest technology, but to adapt the approach to suit local conditions and culture.

To date the results have been dramatic and far reaching. The yard is now adopting a radically new approach to planning and production engineering, to the preparation of production information and to the organization of work on the shop floor.

BACKGROUND

Productivity improvement is a key issue facing the European Community (EC) shipbuilding industry and it will increasingly be so as subsidies are reduced and eliminated under the recent OECD (Organisation for Economic Cooperation and Development) agreement. While there are differences in productivity levels between Community and "best yards" elsewhere, there are also significant differences between the best and worst within the Community. Major improvements in productivity are possible now in most European yards through the adoption of modem shipbuilding techniques in terms of better systems and organization of work, better production engineering, better management and better training.

The policy of the European Commission (the policy-making body of the European Community) towards shipbuilding includes in its objectives

- the promotion of a competitive shipbuilding industry seen as of vital interest to the Community and contributing to its economic and social development; and
- increased efficiency in European Yards.

In January 1992, as part of its continuing monitoring program of developments within the industry and progress towards the achievement of its objectives, the Commission appointed KPMG Peat Marwick in association with First Marine International to carry out a study to assess the factors which affect the competitiveness of the Community yards and to propose ways and means to enhance it. The study was completed in October 1992.

The ENVC yard was part of this study - it was one of the forty-eight yards visited and studied -- and the story begins here. Some additional information is given in the Appendix on the assessment of the use of technology in the shipyards visited at the time and what, broadly, was considered to be best practice. One thing that the study clearly showed was the correlation between the use of best practice, productivity and profitability.

The yard did not show well in the study (see Figure 1). In terms of productivity and in use of "best practice", it was well below average in its category. As a direct result of the findings, the consultants were invited to return to the yard for further investigations, and to design and implement a program for improvement. The object set was to draw up plans for productivity improvement in the widest sense - not just of the direct workforce - but of the whole organization and its activities.

The motivation for the improvement program was clear. The shipyard was government-owned and losing money. Money could continue to be lost at the yard but not for long. The tightening environment of EC

subsidy policy was expected to be increasingly felt.

Added to this was a strong political will for the yard's survival since it was, and still is, a major employer in the northern region of Portugal. Thus there was a strong commitment at the highest level to improve the performance of the yard.

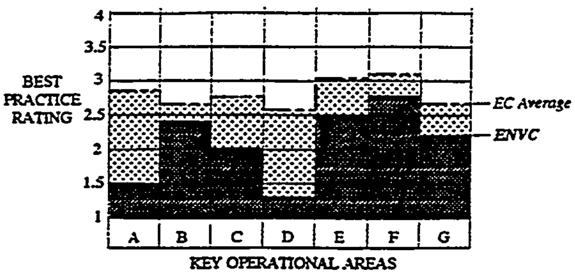


Figure 1
Shipyard Use of Best Practice

THE SHIPYARD

The shipyard is located on a 95 acre site close to the port of Viana do Castelo in northern Portugal. It employs a total of approximately 1,400 people in shipbuilding and ship repair.

Shipbuilding is carried out in a building dock and vessels up to 30,000 dwt. can be constructed. Blocks of up to 140 tonnes can be erected. The shipyard is well equipped with a good range of supporting workshops and other facilities. It carries out ship repair in two graving docks up to 30,000 dwt. (see Figure 2).

BASELINE REVIEW

In January 1993, a detailed review of all shipyard operations was carried out. The objective was to obtain an up-to-date picture of the yard in an international context in terms of competitiveness, level of technology and productivity. It was to identify problem areas, to establish what could be improved, to propose how to manage change and to propose when and what new technology and new ways of working should be introduced.

The review involved interviews with department and section managers, study of systems and procedures,

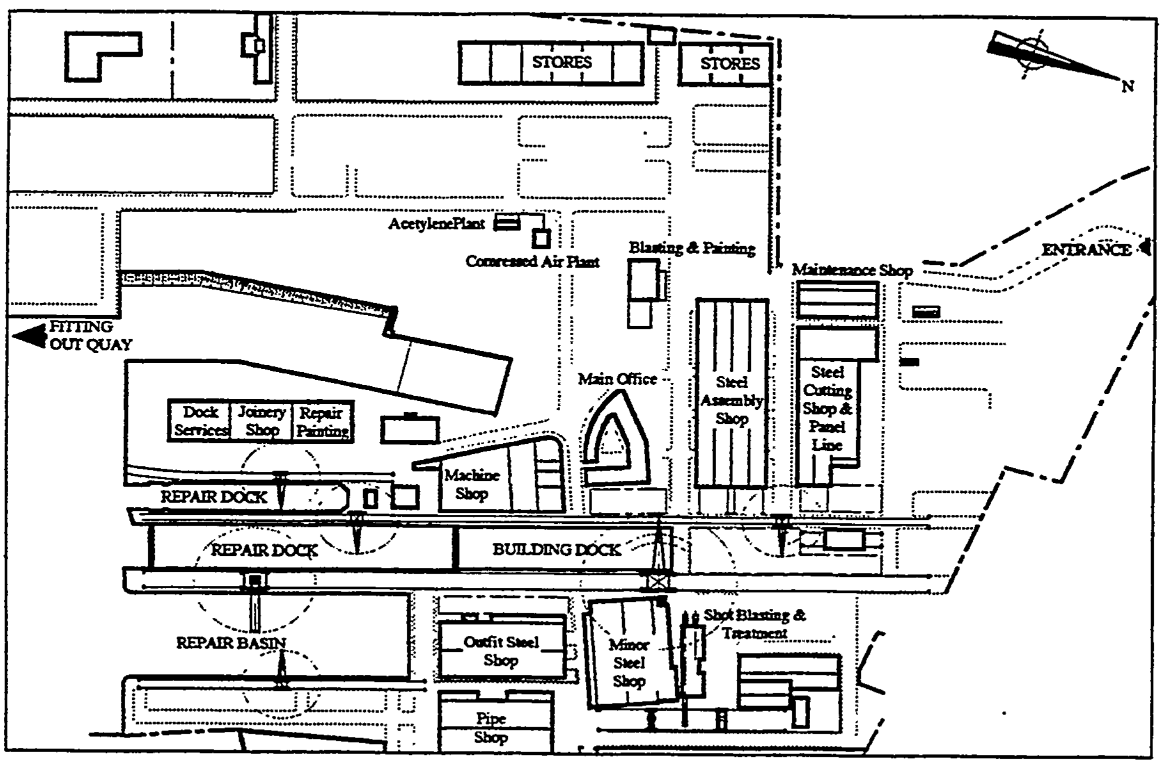


Figure 2
Layout of Shipyard

examination of engineering documentation and production information, critique of the facility development plans and study of working practices. The findings showed nine common features which were identified from the studies in each department, summarized below.

Non Quality Organization

There was a low level of commitment to a "right first time" philosophy with appropriate self checking and feed back systems. This showed in the repeated need for modification and rectification work

Excessive Movement

This related to both manpower and materials and was primarily due to the absence of workstation concepts with proper planning and control systems.

High Work in Progress

Stocks of raw materials and work in progress were appreciably higher than in comparable yards.

Barriers to Change

The organization was heavily oriented towards departments and trades with poor communication between them and with significant barriers to cooperation and change.

Low Customer Orientation

This applied both to external customers and to the adoption of the concept of "supplier / receiver" in internal workflows. This was reflected in the lack of inter-departmental communication, the repeating of the same errors, and the build up of frustration and inter-departmental friction.

Low Awareness of Work Content

Monitoring and control were ineffective in production. Work was planned by large department / section manhour budgets split between shop and ship only. There were significant difficulties in reconciling estimated material and work content with materials consumed and manhours used.

Global Control

At a high level, the company had relatively sophisticated controls. However, performance measurement methods at sub-department and production levels were very under-developed.

Low Organizational Learning

There were few systems for organizing feedback of actual performance or out-turn of activities.

Shipbuilding Technology

In terms of shipbuilding technology, findings included the following.

planning dates were often missed, and poor quality and incomplete work was often passed to the next stage,

there was poor dimensional quality, leading to excessive rework;

there was no clear definition of stages of production and virtually no workstation organization,

outfitting was generally carried out too late in the build cycle and was compressed due to late Steelwork activities,

there was strong trade demarcation, little flexibility and evidence of overmanning; and

the engineering offices were not oriented to steel / outfit integration or ease of production.

In time all these issues would have to be addressed. However, it was clear that it would be very difficult, if not counter productive, to try to address all the issues simultaneously. A phased program had to be developed.

PHASED IMPROVEMENT PROGRAM

The program had to achieve three fundamental objectives

the introduction of new shipbuilding technology and working practices,

- the break-down of the inter-departmental barriers, and
- progressive development of workforce involvement and commitment to the program.

It was decided to construct a three phase program as follows.

Phase 1 - Proving the Concept

This would consist of a number of relatively short term pilot projects aimed at "burning platform" issues in key activities, and involving a wide cross section of the management and workforce.

Phase 2 - Developing the Skills

This would include a series of training and methods / procedures development projects involving transfer of technology which would develop the required approach and skills to enable the concepts demonstrated in the pilot projects to become "the way of life".

Phase 3 - Making it Happen

This would aim to achieve full implementation of the new technology and ways of working into the day to day operations of the shipyard.

The projects were designed to implement change on specific contracts in the building program. The phases were structured to be self contained with definite cut-off points so that at regular intervals, progress could be reviewed and the future program modified as necessary. In addition, the shipyard could decide what level of external assistance (if any) was appropriate for the next stage.

The elapsed time for completion of the total program involving external consultants was expected to be two to three years. Thereafter, the improvement process was expected to be continuous and self generating.

MANAGEMENT OF THE PROGRAM

Critical to the success of any improvement program is the project management organization which must be set up to manage the change process. Immediately following approval of the phased program, a management of change organization was established as outlined in Figure 3.

The Executive Committee was to meet about once a month and was responsible for:

- demonstrating senior management's commitment to and overall sponsorship of the whole program,
- agreeing on individual projects and resources in each phase of the program,
- monitoring progress and achievements, and
- resolving blockages and problems.

Project Steering Groups were established for each project. They were to meet every two to three weeks with responsibility for:

- ensuring the projects proceeded according to the program,
- ensuring the required results were achieved, and
- implementing changes resulting from the projects into their respective departments.

Project Action Teams were led by the project manager. Each action team was made up of staff and workforce from the departments affected by the project and had responsibility for:

- developing and carrying out the project,
- developing the required technology, methods and procedures,
- highlighting problem areas,
- documenting the results and benefits achieved,
- assisting with implementation in their respective departments, and
- assisting with training their own and other department personnel.

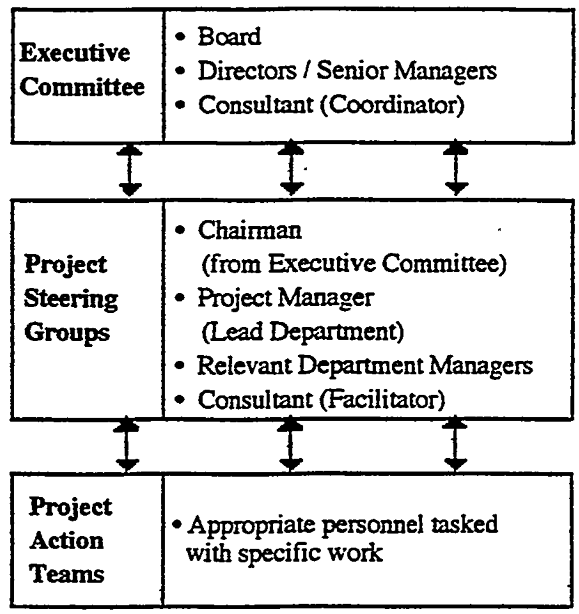


Figure 3
Project Management Organization

The external consultants supported the steering groups and action teams in all aspects of their work, particularly in terms of technical advice. Up to four consultants were on site at any one time but with only a maximum of two for continuous periods.

PHASE 1 - PROVING THE CONCEPT

Five key short-term projects were chosen to act as the initial focus for improvement (see Figure 4). Three were ship related and were designed to be in areas where rapid improvement was possible. They also involved a cross section of both technical and production departments and provided the basis for introducing management of change techniques to key people. Of the other two projects, one addressed the essential area

of human resources, the other looked for short term improvements in general steelwork production operations.

The ship related projects were aimed at impacting two sister ships in the building program to demonstrate the practical effects of new production technology in the areas of steelwork assembly and block outfitting.

ship Related	• Build Strategy * Steelwork Production • Advanced Outfitting
Human Resources	• Attitude Survey
Short Term	• General Steelwork

Figure 4
Initial Projects

Build Strategy

The main object of the build strategy project was to formally agree and document the construction methodology to be adopted for the two ships. This included the identification of potential problem areas and aspects of the vessels which were unusual, together with a description of how the problems would be overcome. In addition, the build strategy described improvements in technology and methods between the first and second vessels, and demonstrated the use of the document as a means of managing change. The project emphasized the need for team work and successfully brought together people from the principal departments of the shipyard.

It was agreed to appoint a project manager for the vessels whose principal task was to implement the build strategy. However, in actual practice, the strategy was not properly followed and the role of the project manager was reduced to that of technical coordinator. The main reason for this failure was the strong departmental characteristics of the company and an underlying resistance to change which was not overcome at this time.

It was not until the third phase of the program that the value of the build strategy and the role of the project manager was properly understood and appreciated.

Steelwork Production

The main object of the steelwork production project was to demonstrate the principles and effects of the workstation concept on engineering and production activities.

Two steel blocks from the subject vessels were selected for the study. The project action team was responsible for:

developing and documenting the detailed assembly methods and the required production information,

- specifying the necessary equipment, tools and manning levels,

organizing and training selected production workers,

setting up areas within the workshops to simulate workstations,

overseeing the project through the production processes, and

documenting results.

The project highlighted the changes in the approach to design and development of production information and in the organization and control of manpower and materials required to implement workstation operations.

The concepts of process analysis and workstation drawing were successfully introduced. In production, the project was initially successful but began to deteriorate as the workforce was changed without adequate training and the work areas were changed without adequate setting up. However, the workstation approach was appreciated by the production workers and supervisors and was adopted for other steel blocks not included in the pilot project. Figures 5 and 6 show samples of block process analysis and workstation drawings.

Advanced Outfitting

The main object of the advanced outfitting project was to demonstrate the principles and effects of new outfitting technology in terms of outfit unit assembly and high levels of pre-erection outfitting in steel blocks (see Figures 7 and 8).

Two sets of system equipment were selected to demonstrate outfit unit assembly and two steel blocks - a funnel and casing, and an upper fore - end were selected to demonstrate the high levels of outfitting that could be achieved. The project action team was responsible for designing the outfit units, determining the levels of advanced outfitting, preparing the necessary production information and planning and organizing the production resources and materials.

The project emphasized the necessity to integrate steel and outfitting activities, both during the design and production stages. It also highlighted the need for a

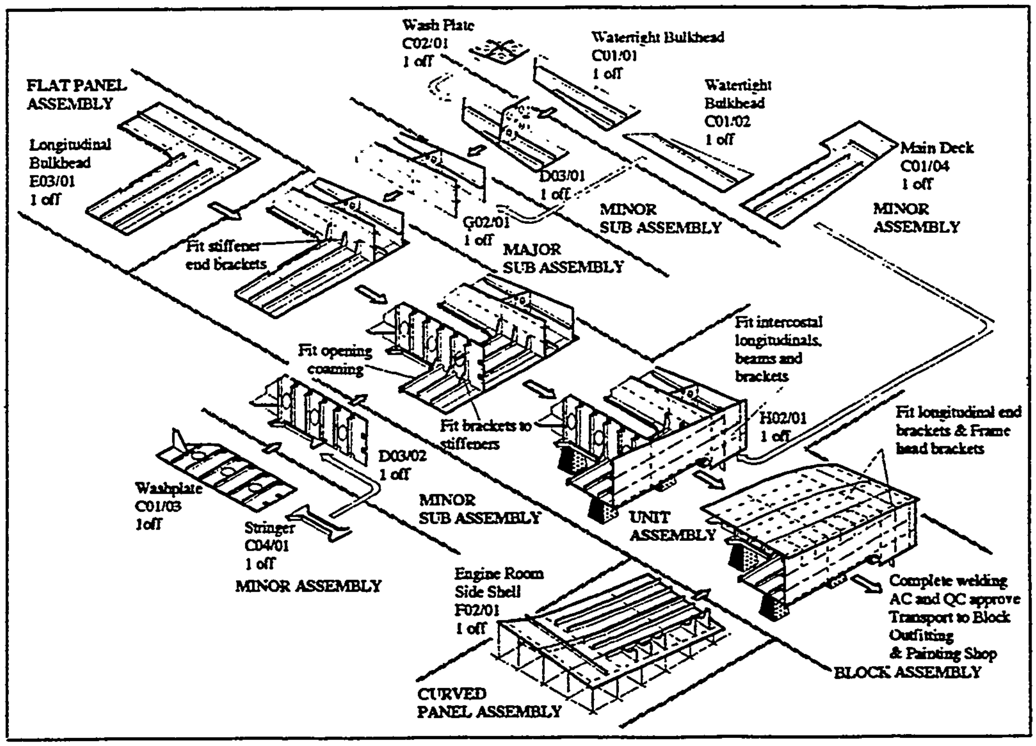


Figure 5
Block Process Analysis

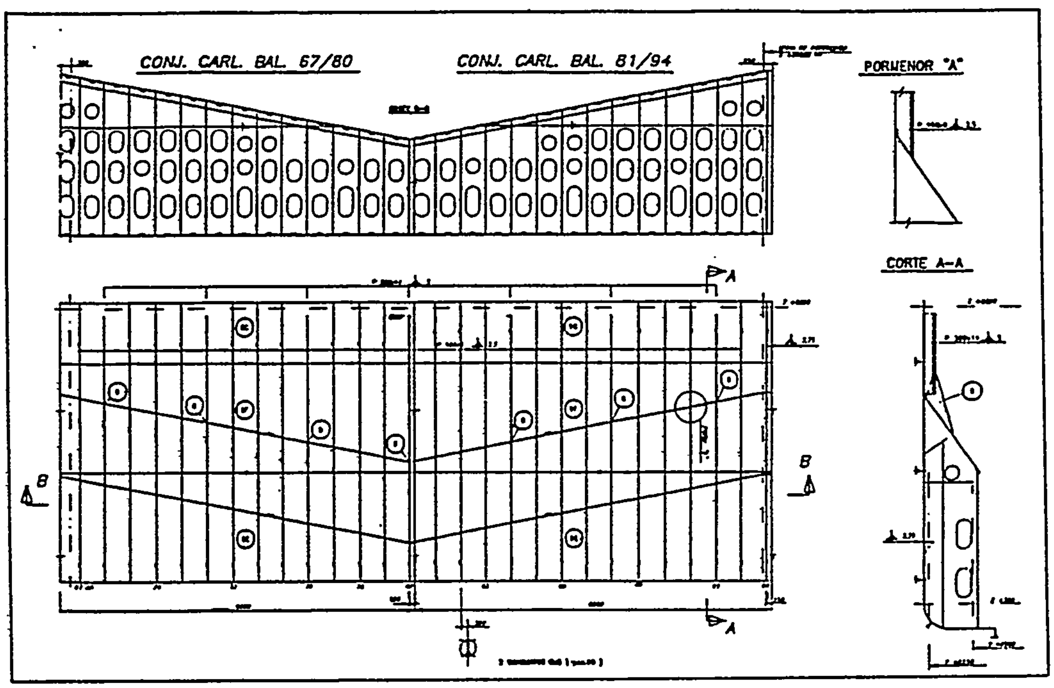


Figure 6
Steel Assembly Workstation Drawing

new approach to the development of outfit design and of the format and content of production information.

In the first of the two vessels, only one of the two outfit units was successfully installed. Both were properly installed on the second. On the two selected steel blocks, a level of approximately 85% of targeted pre-outfit was achieved on the first vessel with 100% achieved on the second.

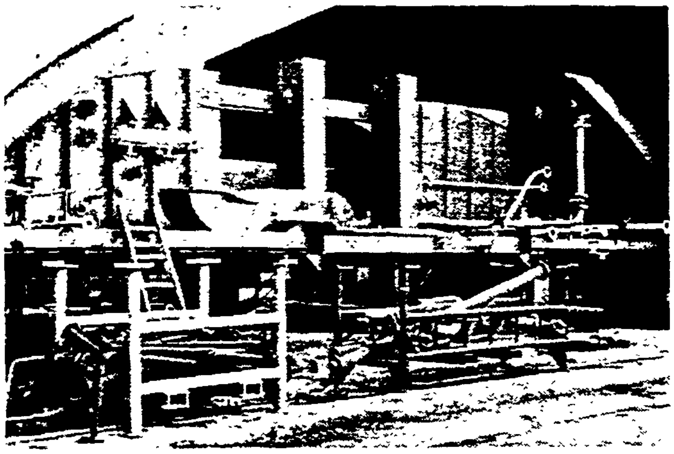


Figure 7
Advanced Outfitting of an Engine Room Deckhead

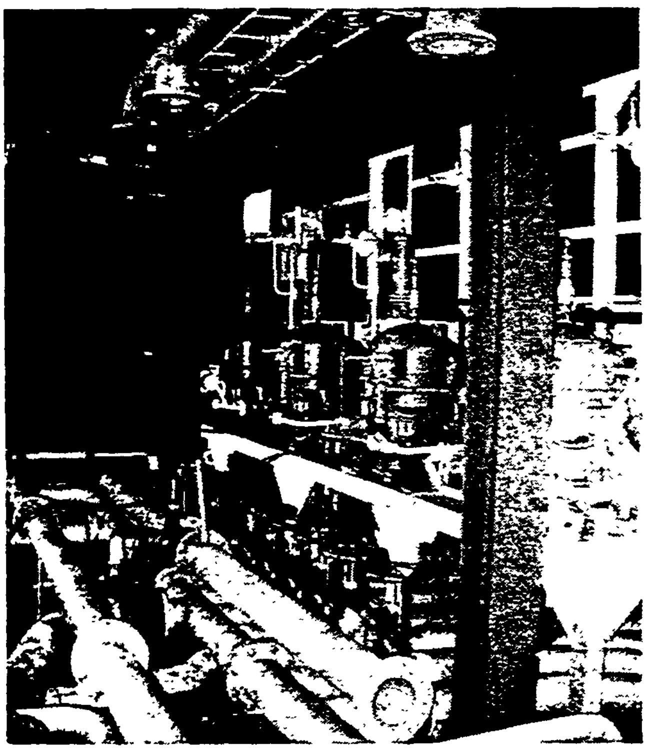


Figure 8
Outfit Unit Installed On-block before Erection

Attitude Survey

The main object of the attitude survey was to develop a better understanding of the different cultures and methods of working which existed in the yard and to develop a series of action plans to gain the commitment of the whole workforce to the improvement process.

The emphasis of the project was to highlight the human barriers which would hinder the progress and implementation of change and to develop the means of overcoming them. An anonymous questionnaire, which all employees were asked to complete, evaluated ten dimensions of human attitude in the company:

- management style,
- clarity of objectives,
- organizational integration,
- decision making,
- performance orientation,
- dynamism,
- professional development,
- image of the organization,
- motivation, and
- change.

The level of response was good, nearly sixty percent of the staff and workforce completed the questionnaire. Answers in each section were rated between 1 and 5 with 5 being the most positive attitude. The survey showed a great variation in attitudes between departments and levels within the organizational structure.

The company was found to be particularly weak in the areas of organizational integration (the extent to which the company achieves efficient communication and cooperation between the different units in the organization), management style (the level of encouragement and support to individual initiative when directed toward an improvement in organizational efficiency) and professional development (the extent to which the company provides opportunities for career development when preparing people for higher level positions). While there was a general willingness to change, this was being prevented by the weaknesses.

Steelwork Operations

The object of the steelwork operations project was to design and manufacture jigs, small tools and fairing aids which could be used immediately in production to improve accuracy, shorten process times and reduce manhours in steel assembly.

The project emphasized the layout and operational changes necessary to implement workstation organization and the need for a structured, analytical approach. This project was a success and implemented

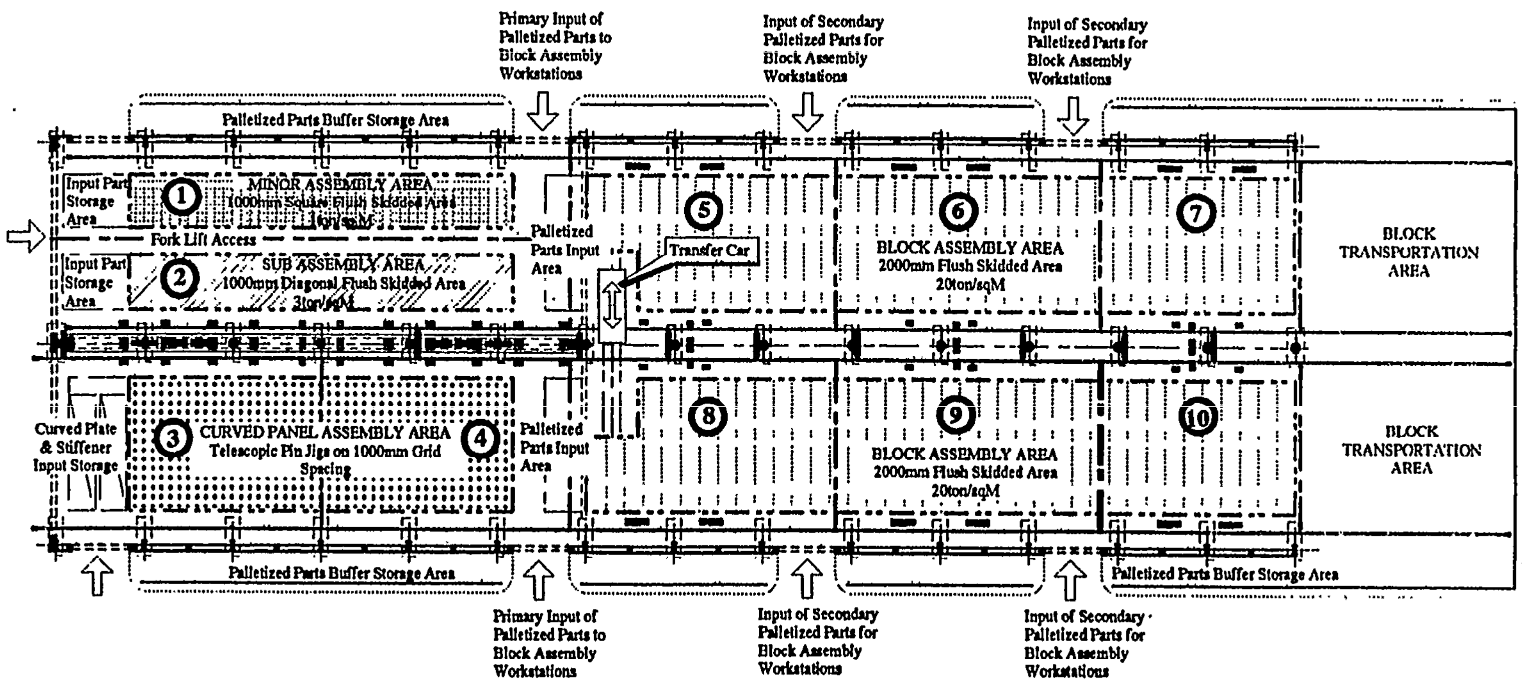


Figure 9
Layout of Steel Assembly Workstations

many beneficial aids to production. Figure 9 shows the layout of workstations in the steel assembly area. Figure 10 shows pin jigs which were designed and manufactured in the yard and Figure 11 shows a number of small production tools and fairing aids

Figure 10
Telescopic Pin Jigs in a Curved Panel Workstation

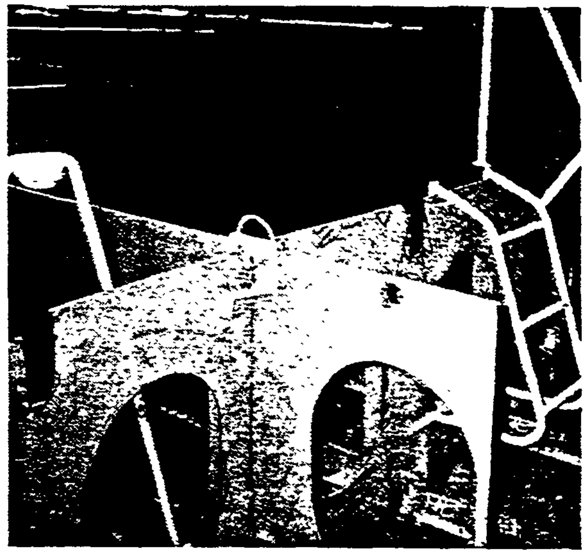


Figure 11
Small Reduction Tools and Fairing Aids

REVIEW OF PHASE 1

Following the completion of the Phase 1 pilot projects a formal review was carried out. This review highlighted a number of problem areas affecting the development and implementation of new technology. The purpose of the review was to help define the precise requirements and shape of Phase 2. The main findings are listed.

Workstation Philosophy. There were widely differing understandings of the workstation concept and the implications for the key departments. For successful implementation there had to be a common understanding throughout the company.

Design / Production Information. The traditional approach to the development of vessel design and the format and content of production information would not support and sustain workstation based production operations and zone by stage outfitting. A new approach needed to be developed.

Planning System. The existing planning system needed overhauling to be effective at all levels and, in particular, to control workstation operations through defined small work packages.

Accuracy Control. An accuracy control program was needed to define and achieve the accuracy requirements for each workstation.

Workstation Operations. The product types, operations, equipment, tooling and manning levels in each workstation needed to be clearly defined.

Management of Change. Broad based training at all levels was required to equip employees and managers with the techniques necessary to implement change.

Professional Development. The process of performance appraisal had to be improved by:
- face to face interviews on a regular basis,
- the setting of clear objectives,
communication to individuals (or teams) of their performance against objectives, and
the design of a fair and defendable promotion system.

Organizational Integration and Management Style. There was the need for a clear definition of the management competencies and style of organization needed to achieve the business strategy. Also, a training program was needed for senior and middle managers to improve team work, communication, decision making and interpersonal skills.

PHASE 2 - DEVELOPING THE SKILLS

Following the review of Phase 1, it was decided by the board that the emphasis of Phase 2 should be in the following four key areas:
workstation operations training,
development of the vessel design process,
development of senior and middle management skills, and

development of workstation operations in steel assembly.

Figure 12 shows the key areas where the development of skills was required.

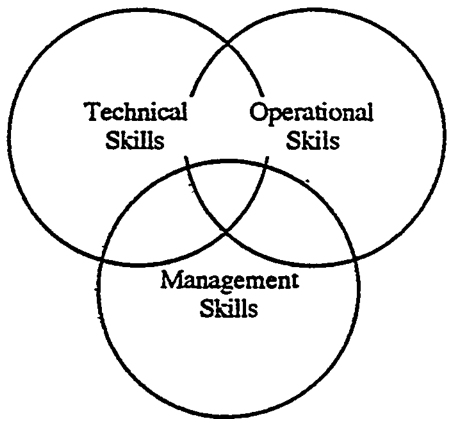


Figure 12
Key Areas for Skill Development

It was decided that the problem areas of planning and accuracy control would be addressed in later phases.

For Phase 2 the executive committee maintained its mode of operation. The steering groups were reconstructed according to the four projects. Each of the action teams formed for the Phase 2 projects included at least one member from Phase 1. In addition, a technology manager was appointed to assume an overall coordination role and, with the assistance of the consultants, to develop an overall technology plan.

Workstation Operations Training

The main object was to achieve a broad understanding of the philosophy, benefits and implications of workstation operations. The action team developed extensive training programs at three levels:

- general instruction for directors and senior management,
- general instruction for middle management, and detail training for production management.

Members of the action team conducted the training sessions which were arranged for groups of six to ten persons. The emphasis of the project was on group participation through open discussion and the setting of tasks for the participants aimed at developing their understanding of the concept and details of workstation operations.

Design and Production Information

The action team produced a "design strategy" document which described the approach to developing design and production information for a vessel through the major stages of the design process. Each stage was described in terms of functional requirements and production considerations and included decision making criteria and samples of the format and content of drawings and documentation. The project emphasized the need for integrating the steelwork and outfit design from the earliest stage.

The strategy document was designed to act as a guide for the engineering departments during the implementation phase. It was to be a dynamic document which could be updated as technology developments called for changes to the design process and the format of production information. Figure 13 shows a summary of the design strategy.

Management Skills Training

The object was to develop modem management style and skills in senior and middle level managers, promoting interdepartmental communication and cooperation for mutual benefit. Training seminars were held for managers at different levels in the organizational structure. Following training seminars, the managers were divided into small groups and given various problems to solve which required joint solutions. The project emphasized the need for close cooperation between managers while providing new techniques and approaches to problem solving.

Workstation Operations

During Phase 1, the layout of the workstations for steel assembly were designed and agreed. The object of Phase 2 was to define the detailed operations and to start implementation.

Previous vessels were analyzed to establish the product families and the throughput requirement for each workstation. Methods and procedures for assembling each product were developed and described in an operations document. Manning levels were determined for each workstation based upon the throughput and methods to be applied.

The project successfully started the implementation of steel assembly workstation operations. The same principles were used to define workstation operations for outfit production, beginning with pipework and

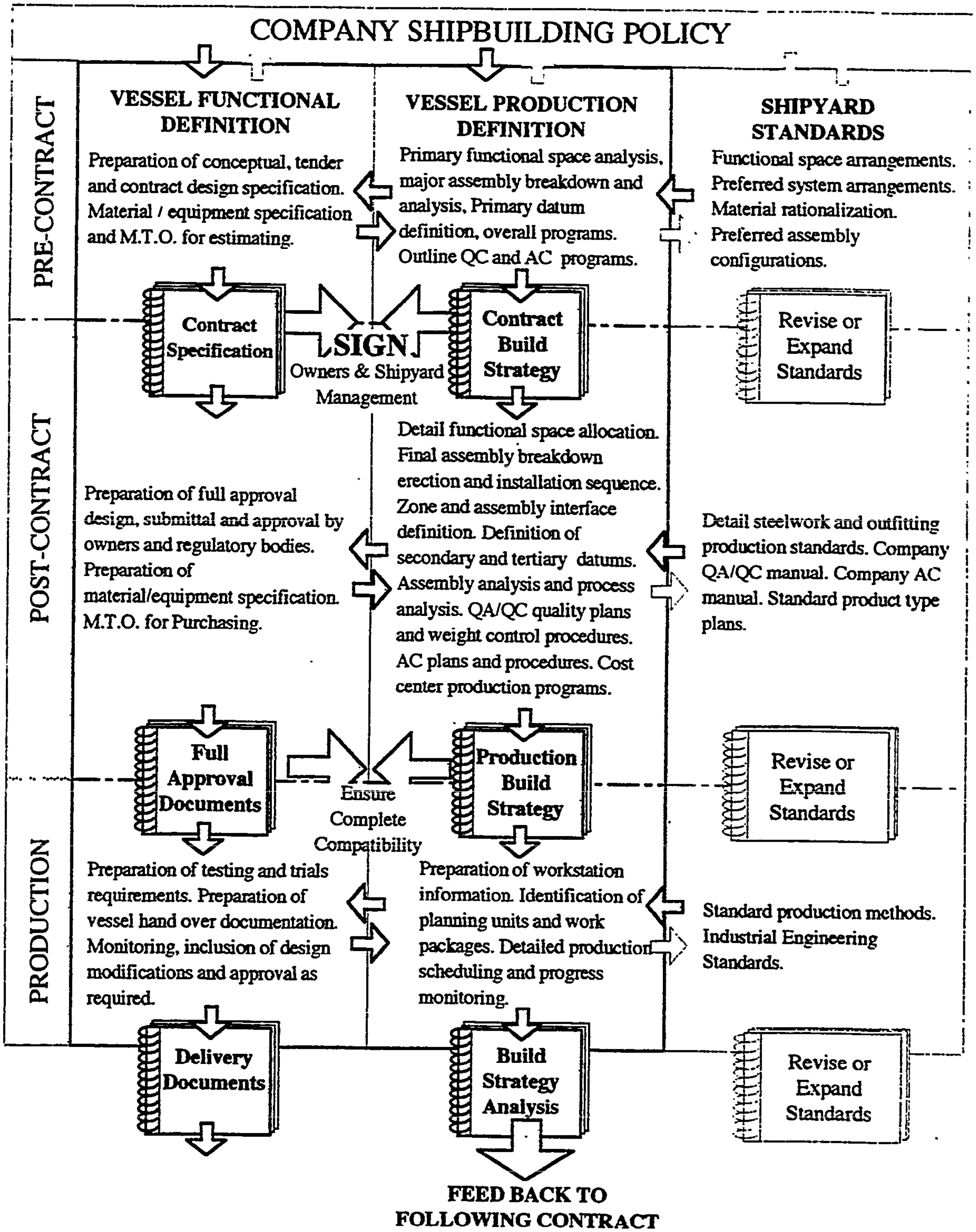


Figure 13
Outline of Ship Design Strategy

progressively moving to other activities. Figure 14 show's the initial stages of developing the minor assembly workstations.

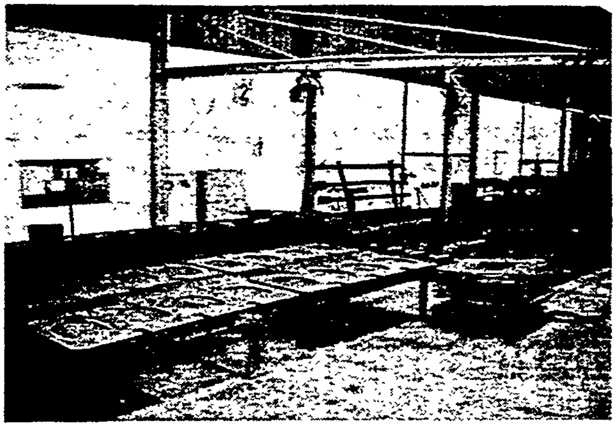


Figure 14
Start of Minor Assembly Workstations

REVIEW OF PHASE 2

By the time the four projects in Phase 2 were complete, the improvement program had been running for approximately twelve months. While they had been generally successful, with many new methods and procedures implemented, it was felt that the individual project approach needed to be expanded to a full implementation program.

With the development of the new "design strategy" and the eroding of departmental barriers, the major obstacles to change were being overcome. However, training needed to be extended, the planning problem remained to be addressed and, in addition, two organizational problems needed to be solved, as described below. Figure 15 illustrates the key areas for further development in Phase 3.

Management Skills Training. Phase 2 focused on basic management skills training for senior and middle managers. This training needed to be expanded to other levels of management and supervision.

Workstation Operations Training. The training needed to be extended to provide detail training for engineering personnel and workstation supervisors.

Planning System. The existing planning system needed to be restructured into a decentralized, three tier system for the effective planning and control of workstation operations.

Production Engineering. There was a need to establish a production engineering function which would lead the build strategy preparation for each vessel and would ensure that new methods and procedures adopted by all departments were adhered to and coordinated. The production engineering function would also be responsible for leading the continuing technology development effort.

Engineering Departments. The traditional steel and outfit department organization was still in place and needed to be changed to multi-disciplined sections developing integrated design and production information.

Extension of Training	. Management Skills . Workstation Operations
PIanning	. New System
Solution to Organizational Problems	. Production Engineering . Engineering Departments

Figure 15
Needs for Phase 3

PHASE 3 - MAKING IT HAPPEN

In late 1993, the yard won an order for the design and construction of an 8,700 dwt. cement carrier. Following the review of Phase 2 in January 1994, the board decided to commit the company to the full implementation of new technology on this vessel. Phase 3 of the program started in earnest in April 1994 and is planned to extend to July 1995 at which time the vessel will be ready for delivery.

Methods and procedures developed in the previous phases are being applied to the vessel, starting with the production engineering of the basic design, preparation of assembly analysis and preparation of workstation production information.

In addition, the following projects identified in the review of Phase 2 are being carried out.

Workstation Training

Detailed training programs arc being written for workstation supervisors and for staff from the engineering, planning and production engineering departments. Applying the methods developed for the

previous training programs using the subject vessel as the basis, attention is being focused on training for workstation operations in both steelworking and outfitting.

Workstation Operations

Implementation of steel assembly workstations is well advanced (Figure 16 shows a bilge sub assembly being completed at a sub assembly workstation). The stages of assembly are clearly delineated in the workshops with appropriate floor skids, jigs and supports, equipment and cranage, access-ways and intermediate storage areas. Implementation is being extended to outfit production activities in preparation for the start of production of the cement carrier.

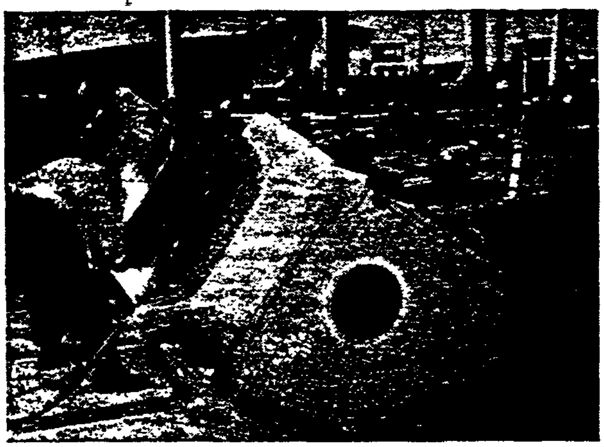


Figure 16
Sub Assembly Workstation

Planning System

The existing planning system has been reviewed and new methods and procedures are being written to describe the detailed operations of a decentralized planning function at three levels:

- strategic planning,
- tactical planning, and
- detail production planning and scheduling.

The new system is being implemented progressively during the design and construction of the vesseI. Figure 17 shows the basic principles of the planning system.

Production Engineering

Organizational and personnel problems made it very difficult for the company to establish a production engineering department at the beginning of Phase 3. However, a planning and production engineering department manager has now been appointed to manage the planning and production engineering tasks which are partly carried out by his own staff and partly carried out by personnel in other departments. While this is not an ideal situation, it is a satisfactory, temporary measure which enables the production engineering principles, developed in the design strategy to be incorporated into the vessel.

In engineering, planning and production areas. the inter-departmental barriers are not totally dissolved and applying certain fundamental production engineering principles is difficult. One typical area involves the block breakdown in the engine room where there has been insufficient consideration of the best breakdown to suit important outfitting requirements.

Figure 18 shows the shell seam at the engine room tank top level whereas it should ideally have been located above the engine room floor plate level. This would have increased the level of advanced outfitting and open-sky access.

Engineering Departments

In the period between the completion of Phase 2 and the start of Phase 3, the company was unable to achieve full integration and reorganization of the steel and outfit engineering departments. A partial reorganization of staff on a ship primary zone basis was achieved and the departments are applying the new methods and procedures set out in the design strategy. This is significantly changing the approach to the detail design of the vessel and the format and content of production information. Workstation drawings are being produced for the steelwork assembly stages and outfitting information is being prepared by zone and stage.

Management Skills Training

The basic management skills training in Phase 2 was conducted entirely by the consultants. In Phase 3, the training sessions are being conducted jointly by consultants and yard staff. The training program is planned to extend from September 1994 to February 1995. It will cover all levels of management and will address the following area:

- strategic management,
- organizational behaviour,
- personnel management,
- time management,
- production management,
- resource administration, command and motivation,
- production results control, and
- leadership.

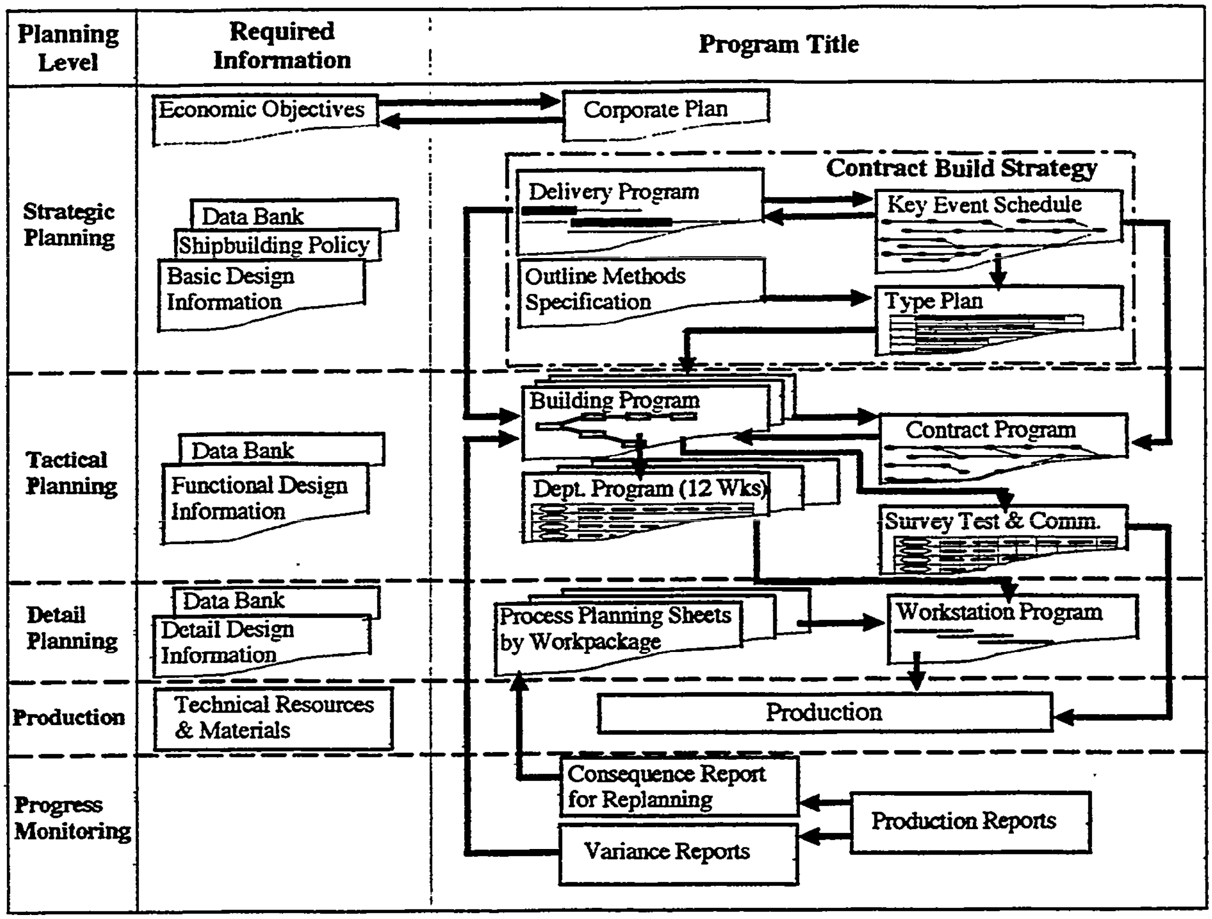


Figure 17
Principles of the Planning System

Figure 18
Shell Seam at Tank Top Level

KEYS TO SUCCESS

While the principles of best practice shipbuilding technology are applicable to all shipyards, their interpretation and incorporation into a structured productivity improvement program must be carefully considered on a yard by yard basis. In this way the very different cultures, personalities, barriers to change and local conditions found in any given situation can be recognized and accommodated.

Throughout the program at the shipyard, much effort has gone into adapting the approach to performance improvement and technology development to suit local conditions and culture. The importance also of simultaneously addressing the elements of new technology and human resources has been stressed, as has the need to ensure that the applied technology is balanced across all shipbuilding activities.

In many shipyards the approach has been to select a

wide variety of projects and to employ large teams of advisors and counterpart managers. In this case the approach has focused on a limited number of projects which affect a wide range of activities and the consultancy team has been kept small. This was considered to give the best chance of success.

The principal role of the consultants has been to act as a catalyst for change by providing the ideas and stimulus through their knowledge of best practice shipbuilding technology and their experience in other shipyards and in other industries. They have acted as advisors on the management of change and have provided detailed, hands on, methods and strategies for the implementation of new technology and ways of working.

There have been compromises in areas where the consultants have wanted to move faster or do things in different ways; but where the shipyarrd, for its own good reasons, has decided otherwise. Mistakes have been made, of course, but some tolerance of failure is necessary for learning organizations and continuous improvement

The improvement program aimed to develop a wide management and workforce involvement and commitment. It was structured to involve a broad cross-section of yard people at all times, and encouragement was given to those involved in projects to develop their own solutions to help avoid the "not invented here" syndrome.

At predetermined intervals in the program, seminars have been held for key employees at which senior managers, supported by the consultants, have reviewed progress, highlighted the successes and failures, and described proposed future program activities. As the projects have progressed, problem areas and results have been presented and discussed with affected management and workforce. This policy of communication at all levels has been essential in gaining the confidence and commitment of the workforce.

In a number of areas, methods and practices from outside the shipbuilding industry have been introduced to avoid traditional incest and inbreeding. Key areas were those of attitude survey, personnel assessment, management organization and management skills training.

In shipbuilding technology, the emphasis has been carefully focused on developing:

- build strategies,
- design for production,
- workstation organization, and
- steel and outfit integration.

Success here has led directly to cycle time reduction and manhour and cost reduction.

In summary, the key factors for a successful productivity improvement program include the following:

- not just commitment from the board and senior managers but their full involvement in project steering groups - this is not something that can be delegated,
- involvement and full communication with all employees,
- emphasis on the shipyard developing its own tailored solutions,
- consultants as trainers and mentors providing solutions as requested,
- parallel development of technology and human resources, and
- clear technological focus.

The object of this whole exercise was to improve competitiveness. In the 1992 EC study, competitiveness was defined as "the ability to win orders in open competition and stay in business". Improving productivity is a means to the end - not the end in itself.

Finally, it is pleasing to note that the yard's orderbook has improved dramatically in the last twelve months as can be seen from the building programs shown in Figures 19 and 20. Continuous improvement in performance is required to meet these new commitments. When this paper is presented it is hoped that further significant progress can be reported.

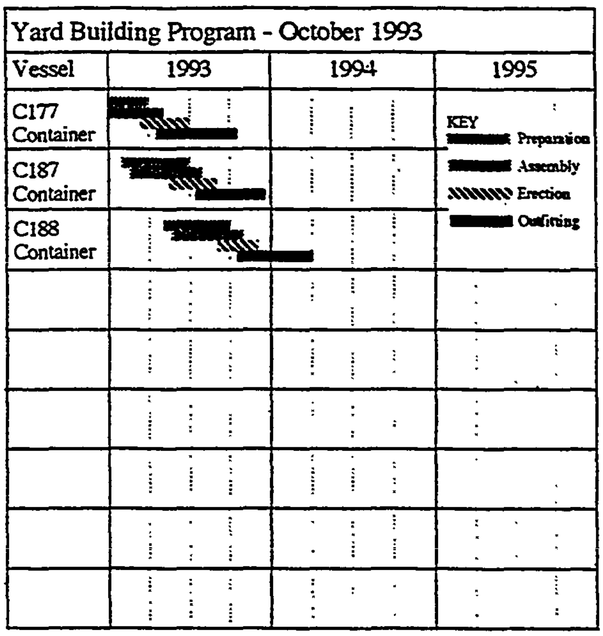


Figure 19
Yard Building Program - October 1993

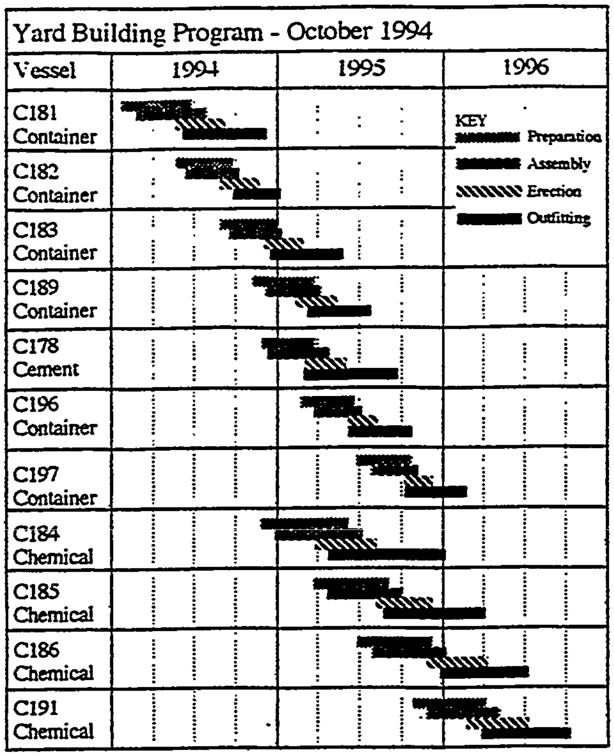


Figure 20
Yard Building Program - October 1994

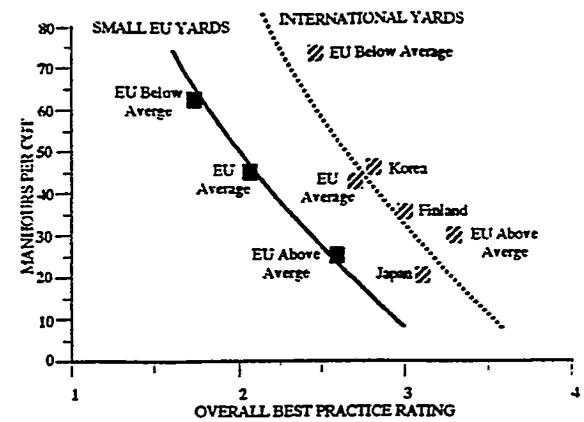


Figure A1
Best Practice / Performance Correlation

	Best Practice Measure	Perform. Measure	Profit Measure
EC Above Av.	117	150	91
EC Av.	96	105	70
EC Below Av.	88	65	23

Table 1
Best Practice / Performance / Profitability Correlation

REFERENCES

KPMG Peat Marwick in association with First Marine International Ltd. "Report of a Study into the Competitiveness of European Community Shipyards" October 1992

APPENDIX

The above referenced EC study proposed that each yard must maximize its use of resources by ensuring that it is using best practice as appropriate to its size, type and individual business objectives. The research program and analysis demonstrated the link between the use of best practice and output performance which is shown in Figure A1.

The study also showed a clear relationship between use of best practice, performance and profitability. Summarized as shown in Table 1.

There are significant differences in the adoption of best practice across EC yards. The features which typify the above average and below average performers in seven key areas of company activity are summarized below.

On strategy and management issues, the above average performing yards have a high degree of focus on a specific target market. This focus links through to clear management objectives and actions in each functional area. In contrast, the below average yards stress the need for flexibility and tend to be trying to service a number of different markets with a mix of one-off builds and short series. This leads to confusion in coordinating departmental organization structures and in the allocation of resources.

On marketing, the higher performing yards tend to have clearly identified and targeted owners, have a policy of pro-active contact with shipowners, see after-sales as another contract opportunity not just a cost, and use their own resources with minimum use of agents. The below average yards tend to be totally re-active to enquiries, view orders as one-offs rather than part of a long term relationship with shipowners, have no clear product development priorities and have very few resources in sales and marketing.

In purchasing, the above average yards tend to have reduced to only two or three suppliers in each area, to operate with few sourcing restrictions and to have explored economies of scale by linking purchasing with

other yards. The below average yards tend to operate within more constraints imposed by their lack of knowledge of external financing sources and to use traditional buyer/seller relationships.

In human resources, the major differences between above and below average yards are in four key areas:

- the emphasis on upgrading skills,
- the effort to restructure the workforce through recruitment,
- the degree of employee empowerment, and
- multi-skilling and re-skilling.

On design and technical issues, above average yards have invested heavily in CAD/CAM systems and equipment with careful implementation, the production of specific workstation information and increasingly full CAD/CAM generation of production information with DNC links. Some of the average and below average yards have made the investment but implementation has been ineffective and not integrated with other operations.

In planning for production, the high performing yards have decentralidized multi-level planning systems with cleary defined outputs at each level, a work package approach to organization of work, formal build strategy documentation, computerized material control systems and pre-production marshaling of kits of parts. The below average yards are ineffective in these areas.

On production, above average yards have short build cycles to maximize the use of facilities. This is achieved by implementing workstation concepts with clearly defined process flows, superior build sequences and early outfitting techniques. There is a high priority on accuracy control and on both designing and organizing out needless work. Below average yards tend to usc a more traditional sequential approach to ship construction.

Additional copies of this report can be obtained from the
National Shipbuilding Research and Documentation Center:

http://www.nsnet.com/docctr/

Documentation Center
The University of Michigan
Transportation Research Institute
Marine Systems Division
2901 Baxter Road
Ann Arbor, MI 48109-2150

Phone: 734-763-2465
Fax: 734-936-1081
E-mail: Doc.Center@umich.edu